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EFFECT OF FREQUENT CUTTING ON THE WATER REQUIREMENT OF ALFALFA AND ITS BEARING ON PASTURAGE.[1]

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INTRODUCTION.

The determination of a plant's efficiency in the use of water at different stages in its development is a problem of much interest, but one which involves serious experimental difficulties on account of the constantly changing environmental conditions and the consequent necessity of extensive multiplication of the series of experimental plants. The present experiments (Table I) were designed to determine (1) whether alfalfa in the early stages of growth following a cutting has a water requirement differing from the water requirement of the plant during the normal period of growth, and (2) to what extent frequent cutting or grazing during the hottest part of the year modifies the seasonal water requirement.

METHOD.

Two standard sets of selected Grimm alfalfa,[2] each consisting of six pots of plants, were employed in these experiments. The plants were treated in the usual way[3] up to the time of the first cutting, on July 26, at which time care was taken to leave the basal shoots, so as to insure the uninterrupted growth of the plants. Following this date, the growth on the pots of series B was cut back weekly in a manner somewhat resembling pasturage (fig. 1), all of the material thus removed from each pot being preserved separately. The growth of the plants in series A was allowed to proceed without interruption

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[1] The experiments reported in this bulletin were conducted at Akron, Colo., in 1912. The methods employed were essentially the same as those described in Bulletin 284 of the Bureau of Plant Industry, entitled "The Water Requirement of Plants. I.—Investigations in the Great Plains in 1910 and 1911." Sealed pots were used to prevent evaporation from the soil and the entrance of rainfall. The writers are indebted to A. M. Peter, R. D. Rands, H. Martin, and G. Crawford for assistance given at Akron in 1912.

[2] The strains were selected by A. C. Dillman, of the Office of Alkali and Drought Resistant Plant Investigations.

[3] See Bulletin 284 of the Bureau of Plant Industry, previously mentioned, for details of these experiments. Series B was, however, started 10 days later than the check series (A), owing to the necessity of replanting.

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until the time of the second cutting (fig. 2). Both sets were then allowed to grow uninterruptedly until the third and final cutting was made. The data for the individual pots will be found in Table I, where the results are also summarized.

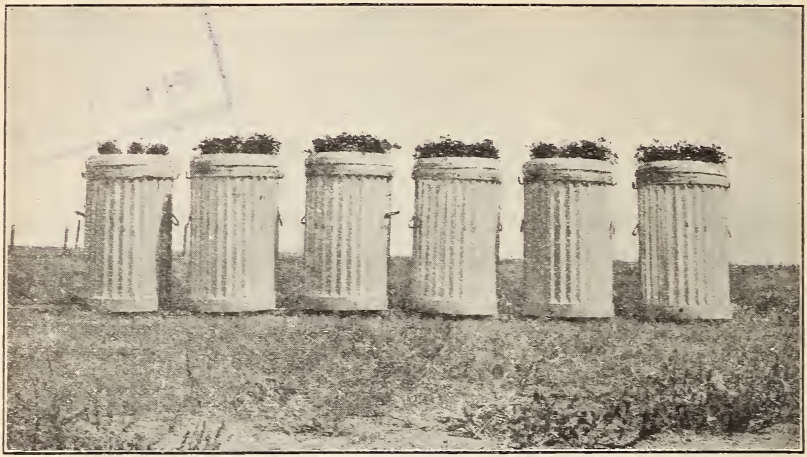

FIG. 1.—Alfalfa (series B, pots 145 to 150), photographed just before cropping, September 7, 1912.

RESULTS.

The water requirement of the two series during the first period (i. e., up to the time of the first cutting) was practically the same. The mean ratio of the six pots of series A (check) was 600 ± 17 and of series B 615 ± 6. The difference is less than the probable error.

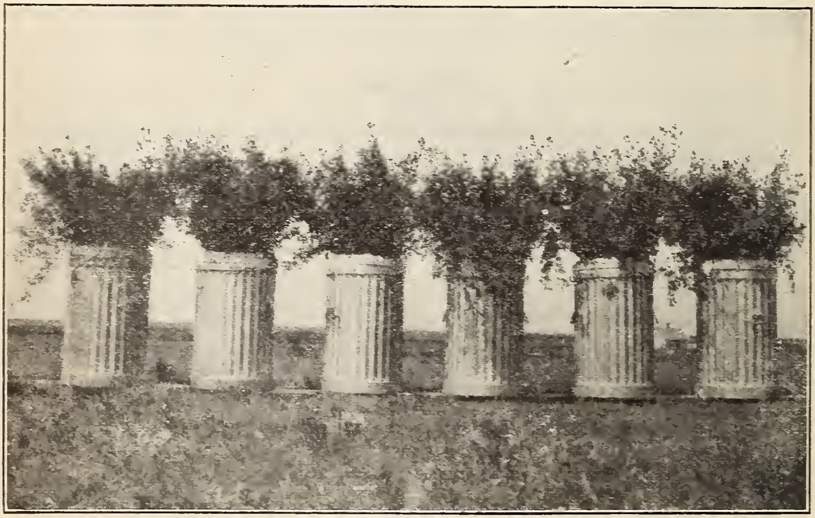

FIG. 2.—Alfalfa (series A, pots 133 to 138), photographed just before the second cropping, September 6, 1912.

TABLE I.—*Dry-matter production and water consumption of alfalfa as affected by frequent cutting, at Akron, Colo., in 1912.*

Period of growth.	Series A: Grimm alfalfa, A.D.I., E-23-20-52 (*Medicago sativa*).				Period of growth.	Series B: Grimm alfalfa, A.D.I., E-23-20-52 (*Medicago sativa*).			
	Pot No.	Dry matter.	Water absorbed.	Water requirement based on dry matter.		Pot No.	Dry matter.	Water absorbed.	Water requirement based on dry matter.
		Grams.	*Kilos.*				*Grams.*	*Kilos.*	
May 24 to July 26	133	131.6	89.6	680	June 3 to July 26	145	53.3	33.1	621
	134	121.4	73.9	609		146	89.3	54.7	612
	135	141.0	82.4	584		147	59.8	37.5	627
	136	140.6	72.5	516		148	78.3	50.5	645
	137	141.4	79.8	564		149	100.6	60.5	602
	138	118.0	76.6	649		150	91.0	53.0	582
Average	......	....	....	600±17	Average	......	....	....	615±6
July 26 to Sept. 6	133	131.7	118.8	902	July 26 to Sept. 7. Cropped Aug. 3, 10, 17, 24, 31, and Sept. 7.	145	20.6	22.5	1,092
	134	110.0	93.0	845		146	25.7	25.1	974
	135	138.6	112.4	810		147	26.8	25.2	941
	136	133.3	115.8	870		148	32.3	28.4	880
	137	135.2	108.1	800		149	23.7	25.7	1,088
	138	120.2	107.4	893		150	30.3	26.4	872
Average	......	....	....	853±13	Average	......	....	....	975±23
Sept. 6 to Nov. 4	133	73.7	35.4	479	Sept. 7 to Nov. 4	145	34.7	15.6	450
	134	64.7	28.1	434		146	37.1	16.5	445
	135	80.7	32.4	401		147	38.8	19.8	510
	136	82.0	32.0	390		148	35.0	16.4	467
	137	83.8	36.1	431		149	39.3	20.1	571
	138	79.5	31.1	391		150	38.3	16.4	428
Average	......	....	....	421±10	Average	......	....	....	479±16
Combined cuttings, May 24 to Nov. 4.	133	337.0	243.8	724	Combined cuttings, June 3 to Nov. 4.	145	108.6	71.2	655
	134	296.1	195.0	658		146	152.1	96.3	633
	135	360.3	227.2	632		147	125.4	82.5	658
	136	355.9	220.3	620		148	145.6	95.3	654
	137	360.4	224.4	623		149	163.6	106.3	650
	138	317.7	215.1	678		150	159.6	95.8	600
Average	......	....	....	656±11	Average	......	....	....	642±6

SUMMARY.

Period of growth.	Total dry matter produced (6 pots).		Total water absorbed (6 pots).		Water requirement.	
	Series A.	Series B.	Series A.	Series B.	Series A.	Series B.
	Grams.	*Grams.*	*Kilos.*	*Kilos.*		
May 24 to July 26[1]	794.0	472.3	474.8	289.3	600±17	615±6
July 26 to Sept. 6	769.0	159.4	655.5	153.3	853±13	975±23
Sept. 6 to Nov. 4	464.4	223.2	195.1	104.8	421±10	479±16
Combined	2,027.4	854.9	1,325.8	547.4	656±11	642±6

[1] Series B was replanted June 3.

During the second period the water requirement of the check series was 853 ± 13, while the series which was cut weekly during this period gave a water requirement of 975 ± 23, an increase of 14 ± 4 per cent. It thus appears that alfalfa is slightly less efficient in the use of water when subjected to weekly cuttings.

During the third period, when both sets were again treated alike, the water requirement of the check series (A) was 421 ± 10 and that of series B 479 ± 16. The B series thus shows during the third period also a slight increase (14 ± 4 per cent) in water requirement compared with series A, which may be the result of the weakening of the plants during the second period through the forced reduction in the leaf and stem area of the plant. This would tend to prevent the normal development of the root system, which in turn would increase the water requirement during the third period, since a relatively greater proportion of food material would be diverted to the roots.

When the water requirement is based on the total dry matter produced during the season (May 24 to November 4) without reference to the time at which the growth occurred, series B is practically as efficient as the check series. The respective ratios were 642 ± 6 and 656 ± 11, the difference, 14 ± 13, being without significance. This is of interest in view of the fact that the water requirement of each of the three crops is higher in series B than in the check series. The explanation of this seeming anomaly is to be found in the relative yields during the second (midsummer) period, during which time series B produced only 18 per cent of its total dry matter, while the check series produced 38 per cent.

The amount of dry matter produced under frequent cutting is also of interest. The check series produced practically the same amount of dry matter during the second period as during the first. Series B produced only 30 per cent as much during the second period, the small plants being unable to elaborate plant material as rapidly as the larger plants of series A. Series B was also maintained during the midsummer period with an actual expenditure of only one-third the water required by the check series. This forced economy in the use of water through frequent cutting seems not to be without effect on subsequent production. Series B produced only 48 per cent as much dry matter during the third period as the check series, while during the first period, notwithstanding the shorter period of growth, series B produced 60 per cent as much dry matter as the check series.

BEARING OF RESULTS ON THE MANAGEMENT OF ALFALFA LANDS.

The results here recorded indicate that the total consumption of water can be controlled to a considerable extent by pasturage or frequent clipping without serious injury to alfalfa plants. This affords a means of limiting the growth of the crop so that its demand for water will not exceed the available moisture supply. With a limited amount of stored moisture it is evident that the greatest production can be obtained by allowing the crop to grow when the water requirement is the lowest, i. e., in the spring or fall, and by keeping the leaf surface at a minimum during the summer through clipping or pasturage. Numerous field observations by the writers have shown the efficacy of reducing the size of the aerial portion of a plant as a means of moisture conservation during periods of drought.

Although frequent cutting or clipping is not practicable under field conditions, the same result can be attained by grazing. Whenever the moisture supply falls short of the amount necessary to produce normal crops throughout the season, summer grazing appears to afford a simple and practical means of obtaining a return from alfalfa commensurate with the available moisture and at the same time reduces the danger of drought injury.

In the pot experiments already described, weekly cutting reduced the total amount of dry matter produced to one-third the normal crop. This would indicate that when the moisture supply is adequate for continuous crop production throughout the season, close pasturage or clipping would result in a marked reduction in the amount of alfalfa produced. Consequently, where grazing is practiced greater production can be secured by intermittent grazing; that is, by employing several fields which are pastured in rotation.

SUMMER PASTURAGE OF ALFALFA EXTENSIVELY PRACTICED IN AUSTRALIA.

Since the experimental work referred to above was completed, the writers have learned that a practice similar to that suggested has been gradually developed in Australia as giving the best return in the management of Australian alfalfa land. The practice is to grow a hay crop in the early spring and to pasture the alfalfa during the remainder of the year. Aside from the hay obtained, alfalfa is very valuable in Australia for grazing purposes, because it responds to summer rainfall, while the native grasses, being annuals, afford no late pasturage. On a large ranch or "station" near Wagga Wagga, New South Wales, one of the writers recently saw 1,000 acres of Peruvian alfalfa that is being handled under this combined system of hay and pasturage. The alfalfa at this station carries three sheep per acre during the summer, autumn, and winter months. About the first of September (early spring) the sheep are taken off. The alfalfa makes a luxuriant growth during the cool spring months, and a crop of from 1,500 to 2,000 pounds per acre of cured hay is obtained. The hay is produced when the weather is cool and the transpiration rate low—in other words, when the crop is making the most efficient use of the water supply. The normal rainfall in this region is about 21 inches and is quite uniformly distributed, each month having more than 1 inch of rainfall and only two months (June and October, corresponding in season to our December and April, respectively) more than 2 inches.

At another station an alfalfa field of 120 acres was seen, which is being treated in the same way. The sheep are taken off the middle of August, and the alfalfa is usually cut the last week in October. The single cutting averages about 1 ton to the acre. The rainfall is about 22 inches a year.

This combined system of hay and pasturage has found much favor in New South Wales and is carried out in a rolling-plains country on loam or sandy-loam soils where there is no possibility of subirrigation.

PUBLICATIONS OF THE DEPARTMENT OF AGRICULTURE RELATING TO THE SUBJECT MATTER OF THIS BULLETIN.

Other publications of the Department of Agriculture in the same field as this bulletin are obtainable from the Superintendent of Documents, Government Printing Office, at the prices specified.

The Water Requirements of Plants. I.—Investigations in the Great Plains in 1910 and 1911. By Lyman J. Briggs and H. L. Shantz. U. S. Department of Agriculture, Bureau of Plant Industry Bulletin 284, 49 pp. and 11 pls., 1913. Price, 15 cents.

The Water Requirement of Plants. II.—A Review of the Literature. By Lyman J. Briggs and H. L. Shantz. U. S. Department of Agriculture, Bureau of Plant Industry Bulletin 285, 96 pp., 1913. Price, 10 cents.

Relative Water Requirement of Plants. By Lyman J. Briggs and H. L. Shantz. Department of Agriculture, Journal of Agricultural Research, vol. 3, no. 1, pp. 1–63, 7 pls., 1914. Price, 25 cents.

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